Space Weather Technical Forecast

Issued on Friday, 09 December 2022 at 01:39 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-Class flares throughout. Chance of G1/Minor Storms Day 1. Increasing chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours. There are eight numbered sunspot regions on the visible disc, and a new yet to be numbered region in the southeast. AR3153 remains the largest region on the disc, relatively stable and inactive, only generating the isolated C-class flares of the period, despite its classification of Fko/beta-gamma-delta. There is another magnetically complex region on the visible disc, as AR3157 also has a small delta spot in one of its intermediate spots, and is classified as Esi/beta-gamma-delta but remains stable. The only region to show some growth, although small, is AR3161, which is now Dai/beta. The remaining regions are all small, stable and magnetically simple.

No Earth-directed CMEs have been seen in available satellite imagery. Although a couple of recent CMEs are being assessed, these are currently considered unlikely to have an Earth directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, showed the onset of a HSS from CH53, perhaps combined with some weak transient influence. Wind speeds quickly increased from slightly elevated levels, around 460 km/s, to elevated levels generally around 550 km/s. The solar wind peaked at 610 km/s at 08/1636 UTC. The density was predominantly above average, with a peak of 15ppcc at 08/0056 UTC, then falling close to average levels late in the day. The IMF (Bt) was strong between 08/0400-1600 UTC, and also at the start of the day, peaking at 12 nT at 08/0940 UTC, and weak for the rest of the time. The north-south component (Bz) was weakly southwardly directed early and late in the day, and predominantly positive in-between, reaching -7nT at 08/0327 UTC. The phi angle was mostly negative (towards the Sun). Geomagnetic activity was Quite to Active (Kp 1-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Low to Moderate levels, peaking at 139 pfu at 08/1320 UTC. The associated 24-hour Fluence remained below Active (1e8 integrated pfu), with a generally decreasing trend. Observed fluence at 09/0001 UTC was 1.28e6 integrated pfu.

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Met Office Space Weather Technical Forecast

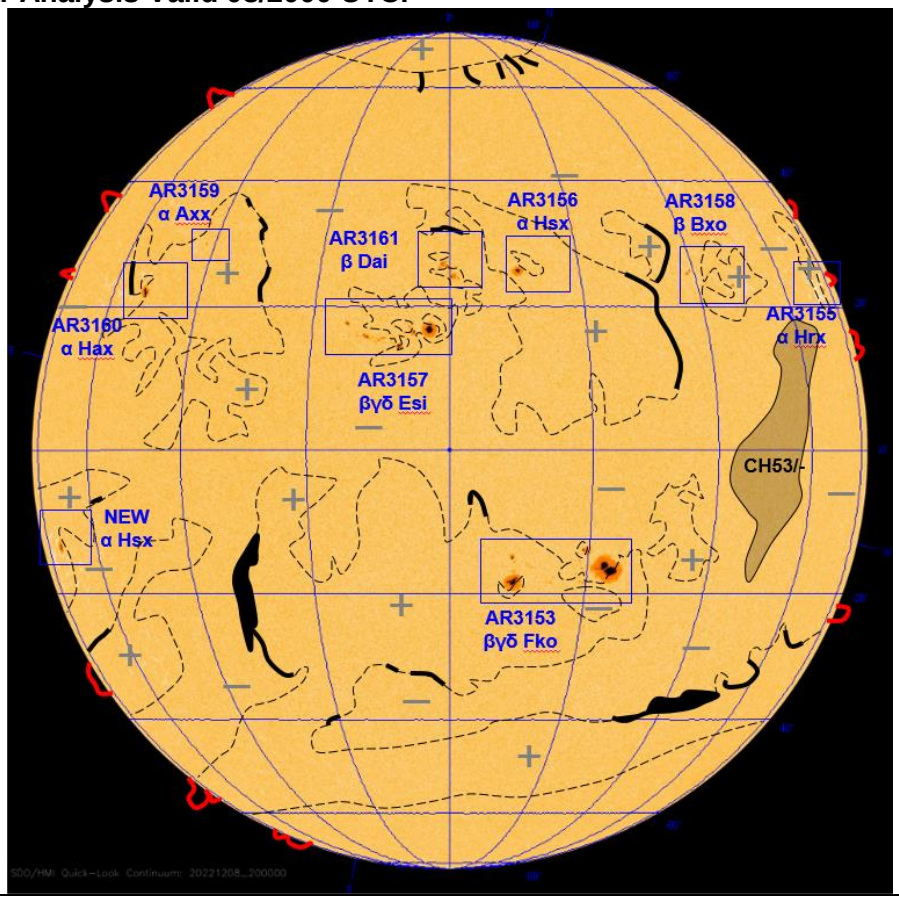
Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to remain at Low levels, with a daily chance of isolated M-class flares, most likely from AR3153 or AR3157.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs have been observed in available imagery. Solar wind speeds are at elevated levels, due to the arrival of a HSS from CH53/-. Elevated solar wind speeds will likely persist for much of today (9 Dec) before steadily declining through the remainder of the period as the influence from the HSS wanes.
Geomagnetic activity is expected to be initially Unsettled to Active (Kp 3-4), with a chance of isolated G1/Minor Storm intervals early and late today due to continued HSS influence. Geomagnetic activity is expected to return to Quiet to Unsettled conditions tomorrow (Kp 2-3), and to predominantly Quiet (Kp 0-2) levels from day 3 (11th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at background levels throughout, with a daily slight chance of seeing S1 levels if any significant flares were to occur. High energy electron flux (greater than 2 MeV), as observed by GOES16, is expected to remain at Low to Moderate levels today and tomorrow, with an increasing trend after this to predominantly Moderate levels for days 3 and 4 (11th and 12th). However, with the continued HSS from CH53, there is a chance that by the end of the electron flux will reach High levels. Electron fluence is currently declining but a recovery is possible through today (9 Dec) with an increasing chance of Active (1e8 integrated pfu) conditions from Day 3 (11th).

Figure 1. Solar Analysis Valid 08/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

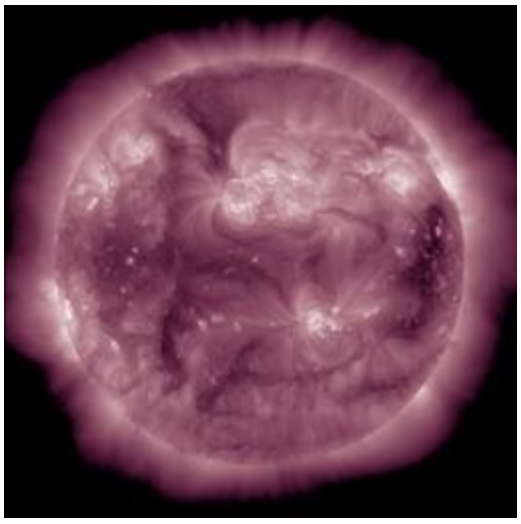
No Earth-directed CMEs have been observed in available imagery.

Solar wind speeds have gradually increased to elevated levels, due to the arrival of a HSS from CH53/-. This is a large coronal hole which dominates the western disc, and is a recurrent feature which is larger and much more pronounced relative to the last rotation. Uncertainty as to the effect of this feature stems from these changes, as well as the temporal proximity to the solstice and bi-annual minima of the geomagnetic effect of high speed streams. Elevated solar wind speeds will likely persist for much of today (9 Dec) before steadily declining through the remainder of the period as the influence from the HSS wanes. MOSWOC Enlil suggests elevated wind speeds today, peaking around 550 km/s before declining through tomorrow, and is currently considered reasonable guidance.

Geomagnetic activity is expected to be initially Unsettled to Active (Kp 3-4), with a chance of isolated G1/Minor Storm intervals early and late today due to continued HSS influence. Geomagnetic activity is expected to return to Quiet to Unsettled conditions tomorrow (Kp 2-3), and to predominantly Quiet (Kp 0-2) levels from day 3 (11th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	20	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Latest SDO/AIA 211 image showing CH53 in the western hemisphere.



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Radio Blackouts - X-Ray Flares:

There are currently eight numbered and one unnumbered sunspot regions on the visible disc. The largest group on the disc remains AR3153, now in the western hemisphere. This region has shown a very slight increase in area of the leader spot, making it asymmetric. The group is now classified as Fko/beta-gamma-delta as a small delta spot remains to the north of the lead spot. The second largest spot group, AR3157, in the northeast also maintains a small delta spot in one of its intermediate spots, and has increased slightly in intermediate spot number. AR3161 in the northeast quadrant has continued a gradual increase in area and spot number, as is now classified as a Dai/beta. The remaining regions have shown little change.

No new significant regions are expected to rotate onto the visible disc until, perhaps, at the end of the forecast period.

Solar Activity has been Low over the last 24-hours, with isolated C-Class flares. Activity is likely to remain at Low levels, with a daily chance of increasing to Moderate through the period, most likely from AR3153 or AR3157.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: AR3153 with latest SDO imagery (left magnetogram and right intensitygram) showing the small delta spot.

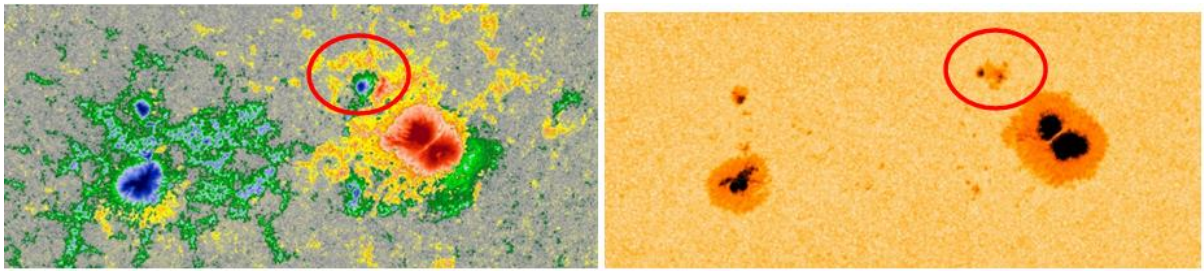

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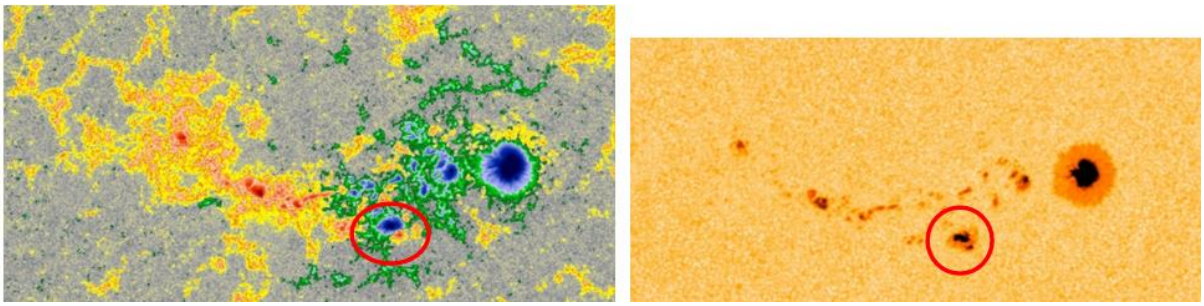
Figure 4: AR3157 with latest SDO imagery (left magnetogram and right intensitygram) showing the small delta spot.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout. However, there remains a daily slight chance of seeing S1 or greater levels at GEO if any significant flares were to occur. This is mainly due to the influence of AR3153 and AR3157, especially as AR3153 is now rotating across the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Low to Moderate levels for the past 24 hours. However, further charging from the current HSS is possible, and electron flux levels may well start to rise again later today.

Therefore a recovery of the corresponding fluence levels is possible, with an increasing trend expected from later today. The MOSWOC REFM is also forecasting an increasing trend, and is therefore considered to be offering good guidance, with the fluence remaining below the Active threshold until at least day 3 (11th).
Confidence in the likelihood of a recovery of electron levels is moderate, but is low for the timing of any increase, as the driving coronal hole during the period is much-changed from the last rotation.

GEO Electron Environment	Level (cm^{-2} sr^{-1}	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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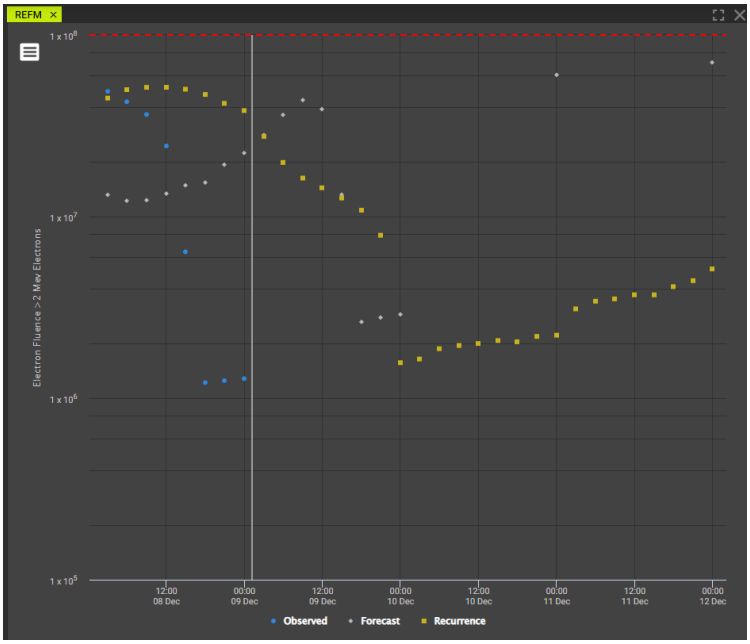
Probability (Exceedance)	day^{-1})	(Yes/No)	(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ 1x10^{8}**	No	20	30	40	50
Very Active	**≥ 2 MeV ≥ 1x10^{9}**	No	1	1	1	1

Figure 5: Met Office REFM Model.



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